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**General Technical
Report RM-183**

Surface Mine Impoundments as Wildlife and Fish Habitat

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Abstract

Past methods of surface mining in the northern High Plains to extract coal, sand, gravel, bentonite, and uranium left a series of blocked drainages and depressions, which later filled with water. These surface mine impoundments, created prior to passage of reclamation laws, provide poor fish and wildlife habitat. These unreclaimed surface mine impoundments, and impoundments created in the future could provide valuable fish and wildlife habitat if recommendations given here pertaining to water quality, impoundment morphometry, and vegetation communities are incorporated into mine plans.

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Introduction

Prior to the enactment of State and Federal laws regulating mining activities, it was common practice to remove and lay aside the overburden, remove the minerals, and then move on to the next site. This practice left a series of barren overburden spoils and mined-out depressions that later filled with water, creating barren surface mine impoundments.

The Surface Mining Control and Reclamation Act of 1977 (P.L. 95–97) prohibited this type of abandonment. Because mining companies are now required to reclaim mined lands to equal the original productivity of the land, very few new surface mine impoundments have been created. However, a well-designed impoundment should be an alternative for reclaiming final cut areas (the last area mined in a surface mine) and areas where mining has destroyed existing wetlands (Parr and Scott 1983).

Approximately 57% of the subbituminous and 97% of the lignite coal reserves of the United States are in the northern High Plains (eastern Montana and Wyoming, western North Dakota and South Dakota, and northwestern Nebraska) (Averitt 1973). This semiarid region also contains significant reserves of other minerals, including sand and gravel, bentonite, and uranium. Surface mining is the primary method of extracting these minerals in the northern High Plains. Creation of carefully designed surface mine impoundments or the reclamation of existing impoundments represent opportunities for improving the quantity and quality of wildlife and fish habitats.

Fish and wildlife habitat studies conducted on livestock watering impoundments in the northern High Plains provide information that can be extrapolated to surface mine impoundments. Most livestock watering impoundments in this region were created by constructing earthen dams across drainages. This paper reviews studies that describe habitat parameters desirable to some targeted fish or wildlife species in the northern High Plains.

Existing Mine Impoundments

Water Quality

McWhorter et al. (1975) demonstrated that the chemical properties of the water in surface mine impoundments are similar to those of the spoil banks surrounding the impoundment. As a result of past mining practices where the deepest earthen material removed was on the top of the spoils, some surface mine impoundments contain water of poor quality. Still, most surface mine impoundments in the northern High Plains contain water suitable for use as drinking water for wildlife and livestock (Goering and Dollhopf 1982, Rumble 1985). However, sulfates, total dissolved solids, and lead concentrations in some surface mine impoundments exceeded the recommended standards for wildlife or livestock drinking water (Rumble 1985). Since other anions are also present in the water, testing for total dissolved solids and evaluating the results against the recommended maximum level of 7,000 ppm can serve as a useful indicator of water quality.

The problem of oxidation of spoil materials and resulting acid run off on eastern coal mine spoils (Crawford 1942, Davis 1971, Dinsmore 1958, Riley 1960, Simpson 1961, Struthers 1964) generally does not occur in the northern High Plains (Olson 1981). Instead, sodium and magnesium sulfates predominate in spoil materials and surface mine impoundment water (Sandoval et al. 1973, Ringen et al. 1979). Existing surface mine impoundments in the northern High Plains, which had pHs in the range of 7.0–9.0 (Anderson et al. 1979), were within recommended limits (McNeely et al. 1979).

Physical Characteristics

Several authors have studied the morphometry and vegetative characteristics of existing surface mine impoundments in the northern Great Plains (Anderson et al. 1979, Bjugstad et al. 1983, Fulton et al. 1983, Rumble et al. 1985). Such impoundments in this region meet few habitat requirements of fish and wildlife (Hawkes 1978). Surface mine impoundments created before reclamation laws were in effect generally have steep slopes below and above water level (Bjugstad et al. 1983, Rumble et al. 1985). Thus, erosion of spoil bank materials and turbidity of water can be extensive (fig. 1). Prelaw surface mine impoundments are also relatively small in surface area and in some cases quite deep; therefore, they have restricted littoral zones with little or no drawdown areas (Rumble et al. 1985). Because aquatic plant community productivity and development are enhanced by littoral zones (fig. 2) and areas of drawdown (Kadlec 1962), unreclaimed surface mine impoundments are not as productive as livestock watering ponds which have more gentle slopes, greater drawdown areas, and more diverse aquatic plant communities (Bjugstad et al. 1983).

The physical nature of the shoreline may restrict the use of surface mine impoundments by livestock and some wildlife species. It is not uncommon for animals, especially sheep, to become stuck in mud or not be able to get up the steep banks of some existing bentonite surface mine impoundments.

Recommendations: How to Make Better Habitat for Wildlife and Fish

Waterfowl

Past research has described the habitat features of livestock watering impoundments in the northern High Plains selected by waterfowl (Evans and Kerbs 1977, Lokemoen 1973, Roberson 1977, Mack and Flake 1980, Rumble and Flake 1983). These may be extrapolated to surface mining impoundments. Waterfowl production on surface mine impoundments will depend on how well three habitat requirements are met (fig. 3): (1) feeding areas for breeding adults; (2) nesting cover; and (3) brood rearing areas (Lokemoen et al. 1984a).

Surface mine impoundments to be managed for waterfowl should have surface areas between 0.4 and 4.0 ha (Proctor et al. 1983, Uresk and Severson 1988). Breeding waterfowl pairs, as well as hens with broods, appear to prefer ponds with greater shoreline length (Mack and Flake 1980, Roberson 1977). Shoreline length is related both to the size of an impoundment and irregularity of the shoreline created by peninsulas and inlets. Uresk and Severson (1988) recommended that the minimum shoreline development (shoreline length divided by circumference of a circle with equal area) index on ponds for waterfowl should be 2.2. Impoundments with 0.4 ha and 4.0 ha of surface area should be designed with at least 493 m and 1559 m of shoreline, respectively.

Impoundments or ponds with several temporary, semipermanent, and permanent wetlands in the immediate vicinity have greater use by waterfowl. Lokemoen et al. (1984a) suggested that the best waterfowl habitats contained about 12–40 wetlands of various sizes and shapes per km^2. Although this density may not be achievable in many areas, it is an indication that "more is better." Higher densities of wetlands also resulted in higher use by waterfowl broods of livestock watering impoundments, probably because the area attracted more breeding pairs (Rumble and Flake 1983).

Shallow, temporary wetlands provide a source of aquatic invertebrates sought by adult ducks in the spring (Krapu 1974, Swanson et al. 1974). These invertebrates are important to the breeding physiology of dabbling ducks (Krapu and Swanson 1975). Abundance and dispersion of aquatic invertebrates has been demonstrated to influence the numbers and habitat selection patterns of waterfowl (Kaminski and Prince 1981, Murkin and Kadlec 1986).

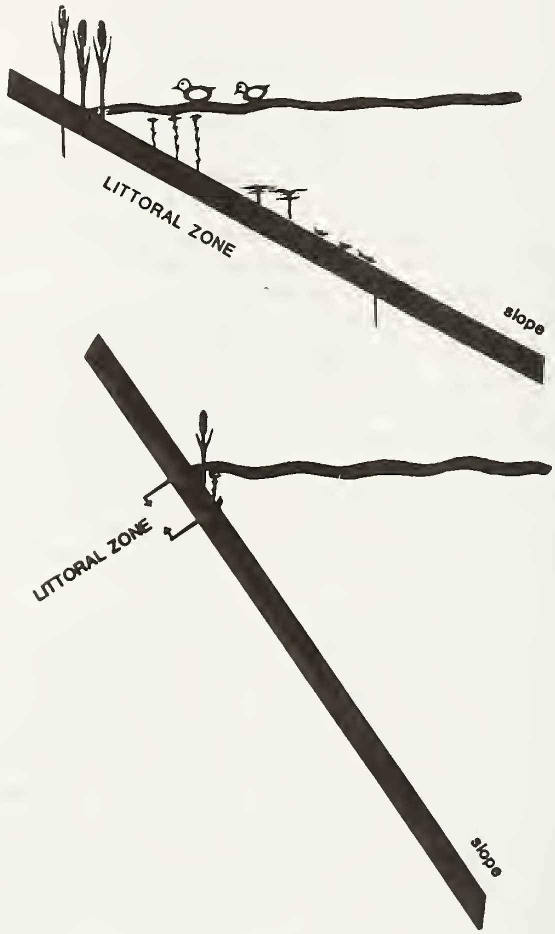

Figure 2.—More gentle slopes mean greater areas of the pond bottom receive enough sunlight to support diverse aquatic plant communities.

Figure 1.—Steep slopes lead to high erosion, high turbidity, little emergent vegetation, and poor wildlife and fish habitat.

Figure 3.—Good waterfowl habitat includes feeding areas, nesting cover, brood rearing areas.

Waterfowl use of impoundments is greater where diverse aquatic vegetation communities are interspersed with open water (Beard 1953, Kaminski and Prince 1984). Brood-rearing ponds should contain habitats typical of a "deep marsh" (Stewart and Kantrud 1971) until at least mid-August (Lokemoen et al. 1984a). Mallard broods appeared to prefer impoundments with emergent stands of roundstem bulrush (*Scirpus*), spikerush (*Eleocharis*), and smartweed (*Polygonum*) (Rumble and Flake 1983).

Management of impoundments for waterfowl should be directed at maintaining 1500 stems/m^2 of aquatic vegetation in shallow areas (Uresk and Severson 1988). Submersed vegetation provides habitat for aquatic invertebrates (Moyle 1961) and livestock watering impoundments with extensive stands of submersed vegetation had greater use by waterfowl broods (Rumble and Flake 1983). Since use of man-made impoundments by duck broods was greater on ponds with higher densities of benthic invertebrates, impoundments should be managed to maintain at least 150 benthic organisims/m^2 (Belanger and Couture 1988).

Aquatic plant communities can be managed by managing the depth of the water. Emergent species of vegetation, except "hybrid" cattail, were killed at water depths greater than 60 cm (Harris and Marshall 1963), and 76 cm of water appeared to thin out "hybrid" cattail stands (Lind et al. 1976). If dabbling ducks are the management objective, impoundments should be between 0.3 and 2.0 m deep, and less than 60 cm deep over 30–70% of the pond area; for diving ducks the depth should be between 0.6 and 2.4 m and average 1.0 m (Lokemoen et al. 1984a, Monda and Ratti 1988, Proctor et al. 1983, Uresk and Severson 1988).

The abundance of nesting cover is related to waterfowl use of ponds (McEnroe 1976); intensive grazing of pastures surrounding ponds resulted in decreased waterfowl breeding pairs (Roberson 1977). Ducks and geese readily nest on islands, sometimes in very high densities, if they are secure from predators (Lokemoen et al. 1984b). Creating islands in surface mine impoundments will therefore improve the quality of the nesting habitat for ducks and geese (Proctor et al. 1983). Islands in impoundments less than 20 ha in size should be 6–12 m across (Guthery and Stormer 1984). Dense grass or brushy shorelines are also preferred by waterfowl broods (Gjersing 1975, Rumble and Flake 1983).

Livestock management practices such as deferred or rest rotation grazing systems, distributing salt in pastures, and maintaining proper use on adjacent grazing lands will help meet some of the habitat requirements of waterfowl. Fencing portions of lands adjacent to impoundments where livestock concentrate for drinking water may be necessary in some situations so that shoreline and emergent vegetation are maintained.

Other Avian Species

Surface mine impoundments that can be modified or created to provide waterfowl habitat should also attract

Figure 4.—Good habitat for waterfowl is also good habitat for other nongame avian species.

shore birds and some upland bird species (Evans and Kerbs 1977, Hawkes 1978, Schaid 1979, Uresk and Severson 1988) (fig. 4). Sharp-tailed grouse, prairie chickens, sage grouse, and pheasants all require water under the semiarid climate of the northern High Plains. These birds will also use vegetation surrounding impoundments for protective cover. By reducing slopes and creating irregular shorelines with inlets and peninsulas (Olson and Barker 1979) and then maintaining adequate shoreline vegetation, most surface mine impoundments can become valuable wildlife habitat. If aquatic or shoreline vegetation does not become established readily, transplants can be used to start development of vegetation communities (Fulton et al. 1983).

Fish

Surface mine impoundments in the northern High Plains can also provide habitat for fishes. One of the most important requirements for impoundments to be stocked with fish is a permanent supply of water of adequate quality (Proctor et al. 1983). For the most part, the water quality in surface mine impoundments is acceptable for fish (Anderson et al. 1979). Some surface mine impoundments have been stocked with walleye (*Stizostedion canadense*), largemouth bass (*Micropterus salmoides*), catfish (*Ictalurus* spp.), and rainbow trout (*Salmo gairdneri*).

Impoundments greater than 0.8 ha require less management input (SCS 1971), and ponds less than 0.4 ha surface area probably will not sustain fish for long without management (Marriage and Davison 1971). Littoral zones, areas with water less than 1 m deep, are productive areas of food for some fishes. Although vegetation in the littoral zone provides food cover for young fish, vegetation of fish ponds should occupy less than 25% of the pond area (Scalet and Modde 1984). At least 25% of the pond area should be greater than 3.0 m deep if a fishery is a reclamation goal (Scalet and Modde 1984, U.S. Department of Agriculture 1971).

Turbidity in ponds reduces light penetration through the water which reduces the potential productivity of

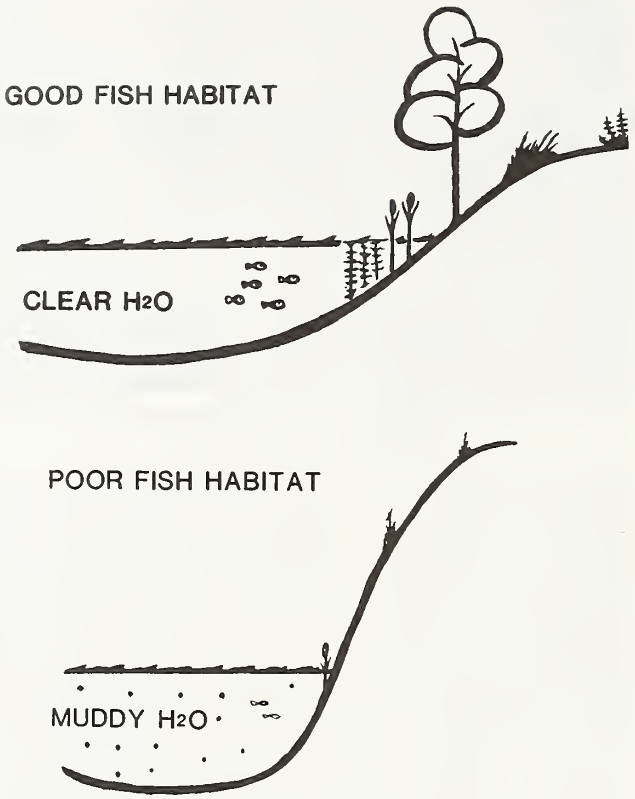

Figure 5.—Gentle slopes lead to clearer water, more shoreline vegetation, better fish habitat.

a pond (fig.5) and indirectly slows fish growth (Hawkes 1978). Turbidity is high in many bentonite surface mine impoundments due to the colloidal properties of the sediments. Steep slopes of surrounding spoil materials erode easily and contribute to high turbidity in impoundments. Scalet and Modde (1984) recommended that shoreline banks be sloped to a 3:1 ratio. Replacement of topsoil and re-establishment of vegetation on shorelines and adjacent spoil banks can reduce the high turbidities found in many existing surface mine impoundments.

Conclusions

Many surface mine impoundments in the northern High Plains can be modified to provide desirable and unique fish and wildlife habitats by following current reclamation laws and incorporating features that have characteristics important to targeted wildlife and/or fish species. Management criteria established for livestock impoundments are applicable for reclamation of surface mine impoundments. The planning and construction of new surface mine impoundments in surface mine operations should be encouraged to enhance the diversity of habitats for fish and wildlife in this semiarid region.

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Unreclaimed surface mine impoundments provide poor fish and wildlife habitat. Recommendations given here for reclaiming "prelaw" impoundments and creating new impoundments could provide valuable fish and wildlife habitat if incorporated into existing laws and mine plans.

Keywords: Surface mine impoundments, fish habitat, wildlife habitat, reclamation

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